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Outcomes following minimally invasive lateral transpsoas interbody fusion for degenerative low grade lumbar spondylolisthesis: A systematic review

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ABSTRACT

A variety of surgical approaches have been described to treat low grade lumbar degenerative spondylolisthesis (DS). Minimally invasive spinal fusion techniques were first introduced to minimize morbidities associated with invasive surgical treatments. Minimally invasive lateral transpsoas interbody fusion, also known as lateral lumbar interbody fusion (LLIF), is a relatively new method of lumbar arthrodesis that avoids various approach related complications compared to its posterior and anterior counterparts.

A systematic and critical review of recent literature was conducted in accordance with PRISMA guidelines. The sources of the data were PubMed, MEDLINE, Embase, Cochrane and Scopus. Key search terms were "transpsoas", "interbody fusion", "LLIF", "XLIF" and "spondylolisthesis". Papers included in the review were original research articles in peer-reviewed journals. The articles were thoroughly examined and compared on the basis of study design, outcomes, and results. Only studies which met the eligibility criteria were included.

Eight studies were included in the qualitative and quantitative analysis (three retrospective, four prospective, one randomized controlled trial). A total of 308 patients (227 females) (pooled age 64.5 years) and a total of 353 operated levels were analyzed. Mean follow up time ranged from 6.2 to 24 months. There were no reported cases of durotomies or pseudarthrosis in any study. All neurologic complications were reported to be transient with no permanent deficits. Mean improvement in ODI scores ranged between 19.5 (38.6%) to 36 (54.5%). Mean improvement in slip ranged from 47 to 67.5%. Three studies also reported that patient satisfaction and willingness to undergo the procedure again approached 90%.

Minimally invasive transpsoas interbody fusion possibly leads to favorable clinical and radiological outcomes while avoiding the possible complications of its more traditional open and minimally invasive counterparts. Further studies are needed to better establish its role in the management of low grade degenerative lumbar spondylolisthesis.

1. Introduction

Spondylolisthesis, defined as the displacement of a vertebral body relative to the segment below, is an important pathology in the aging adult lumbar spine that can present as axial low back pain, radiculopathy or neurogenic claudication [1]. Surgical intervention is warranted in cases of refractory symptoms or when conservative management has failed [2–5]. Traditional surgical treatment options have ranged from decompression alone or decompression with fusion (anterior or posterior) with or without listhesis correction to multilevel fusion for deformity correction [6,7]. Within the last decade, the advent of modern minimally invasive surgery (MIS) techniques has shortened operative times while minimizing blood loss, soft tissue dissection, muscle damage as well as postoperative incisional pain [33]. Compared to patients with degenerative disc disease, adjacent segment disease and post-laminectomy syndrome, patients with degenerative spondylolisthesis have been reported to have greater improvements in disability after lumbar fusion [23,34].

A variety of MIS arthrodesis techniques have been described, including anterior, posterior or transforaminal lumbar interbody fusion. Minimally invasive lateral lumbar interbody fusion (LLIF), also known as extreme lateral interbody fusion (XLIF, NuVasive) or direct lateral interbody fusion (DLIF, Medtronic, Memphis, TN, USA), was first described by McAfee in 1998 [8]. The procedure employs a minimally invasive retroperitoneal transpsoas approach to the lumbar spine using a tubular retractor system under real time electrophysiologic

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monitoring to avoid injury to the nerves of the lumbar plexus.(REF) Compared to conventional techniques, it avoids various approach-related morbidities such as vascular complications, bowel injury associated with an anterior approach and injury to the dura and nerve roots with posterior approaches [18]. Furthermore, it allows preservation of posterior bony elements and back muscles thus sparing spinal stability. It also allows the placement of a larger interbody cage thereby raising disc height and achieving indirect decompression of the neural foramen [35].

To the best of our knowledge, no review has analyzed the clinical, perioperative and radiological outcomes of LLIF for the treatment of spondylolisthesis. The aim of our study is to conduct a systematic review of available literature to evaluate the aforementioned outcomes in patients with low grade spondylolisthesis.

2. Materials and methods

2.1. Literature search

This study adhered to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines [9]. A comprehensive search of several databases from each database's inception to February 1st, 2017, any language was conducted. The databases included Ovid MEDLINE Epub Ahead of Print, Ovid Medline In-Process & Other Non-Indexed Citations, Ovid MEDLINE, Ovid EMBASE, Ovid Cochrane Central Register of Controlled Trials, Ovid Cochrane Database of Systematic Reviews, and Scopus. The search strategy was designed and conducted by an experienced librarian with input from the study's principle investigator. Controlled vocabulary supplemented with keywords was used to search for lateral transpsoas interbody fusion for spondylolisthesis. Manual search of reference lists was also performed to ensure relevant studies were not missed The keywords used for the search were: lateral transpsoas, LLIF, XLIF, DLIF, extreme lateral interbody fusion, spondylolisthesis.

The actual strategy is available from the reprint author. Risk of bias assessment was conducted using the Newcastle-Ottawa scale [32]. Final evaluation of the confidence of the estimates was estimated by the GRADE approach [36].

2.2. Selection criteria

Eligibility criteria included the following reporting of: (1) patients aged > 18 years, (2) confirmed diagnosis of degenerative or isthmic lumbar spondylolisthesis of grade 1 or 2, per the Meyerding classification [10] and (3) at least one of the following outcomes: operative time, blood loss, hospital stay, fusion rates, complications, pre- and postoperative functional and pain scores by Oswestry Disability Index (ODI), the 36-Item Short Form Health Survey (SF-36) and Visual Analog Scale (VAS), patient satisfaction and willingness to undergo the procedure again, radiological outcomes including improvement in slip, improvement in disk height, improvement in foraminal height and fusion rate.

Exclusion criteria included: (1) less than 10 patients per study arm; (2) cohorts involving other diagnosed lumbar degenerative disorders without spondylolisthesis; (3) editorials, case reports, case series, reviews, opinion and commentary articles.

2.3. Data extraction

The extracted data included: study design, patient demographics, relevant clinical history, operative variables (i.e. Meyerding grade, supplementary instrumentation/posterior decompression and number of vertebral levels fused), operative outcomes (i.e. operative time, intraoperative blood loss, length of hospital stay) as well as intraoperative (durotomy, fracture etc) or postoperative complications. Improvement in ODI and VAS scores for back pain and the improvement in quality of life as per the SF-36 questionnaire was also reported. Data on radiological outcomes such as fusion, improvement in slip, disc height, foraminal height, change in segmental and lumbar lordosis was also recorded. Data extraction from articles, tables and figures was performed by one reviewer (A.G) with accuracy of data entry confirmed by second reviewer (P.K.).

2.4. Statistical analysis

Descriptive statistics, i.e. means and standard deviations for continuous outcomes; frequencies with proportions for categorical variables, were used to present the available information. Pooled results for the outcomes of interest were calculated using a weighted distribution.

3. Results

3.1. Search results

Our literature search yielded 143 studies of which 100 unique abstracts were assessed. After review of 21 full-text articles, a total of 8 studies were included in the qualitative and quantitative analysis [24–30,37,38] (Fig. 1). Table 1 summarizes study characteristics. Seven studies were single-institution (three retrospective, four prospective cohorts) and one study was a multi-institution randomized controlled trial comparing lateral with transforaminal interbody fusion for low grade spondylolisthesis. Seven studies were conducted in the USA and one study in Brazil. The risk of bias by the Newcastle-Ottawa Scale was found to be low in all studies. Using the GRADE approach, confidence in quality of evidence for outcomes was rated low to moderate. (Table 6)

3.2. Demographics

Three hundred and eight patients were analyzed, of which 227 (74.8%) were females. Mean age ranged from 58.6 to 68 (pooled mean: 64.5). Five studies (n = 188) specifically reported the grade of spondylolisthesis; of 188 patients, eighty eight patients (46.8%) had grade 1, while one hundred (53.2%) had grade 2. A total of 81 patients were reported to have had previous lumbar spine surgery across four studies (n = 193). Mean follow-up time ranged from 6.2 to 24 months.

3.3. Intraoperative data (Table 2)

A total of 353 levels were operated on across all studies, with L4–L5 being the most commonly involved level (n = 256, 72.5%), followed by L3–L4 (n = 80, 22.6%), L2–L3 (n = 13, 3.6%), L1–L2 (n = 2, 0.5%) and L5–S1 (n = 2, 0.5%). With regards to additional procedures, seven studies (n = 253) employed posterior instrumentation, while one study [29] employed spinal decompression in 26 patients (43.3%). Seven studies (n = 286) reported employing EMG monitoring during the procedure. Six studies (n = 219) reported mean operative time, which ranged from 73.2 min to 260 min (pooled mean: 174.8 min). Five studies (n = 164) reported estimated blood loss (EBL) as a mean value, which ranged from 83 mL to 438 mL (pooled mean-170 mL). One study (n = 63) reported EBL as mean decrease in Hb, which was 1.4. Another study (n = 29) reported it in terms of a reference value of < 100 ml; 79% cases had EBL of < 100 ml. Five studies (n = 199) reported mean length of stay, which ranged from 1.2 days to 3.5 days (pooled mean: 1.8 days).

3.4. Complication rate (Tables 2 & 4)

Intraoperative complications were rare (n = 3) with two cases of intraoperative endplate fracture, one case of a broken guidewire during pedicle screw placement. There were no documented durotomies. Seven studies (n = 245) reported rates of postoperative thigh numbness ranging from 5 to 33% (pooled mean: 14.3%) and six studies (n = 214)